

Remarks:

Reconsideration of the application is requested.

Claims 1 and 3-12 remain in the application. Claim 1 has been amended. Claim 2 has been cancelled.

In deference to the requirement in item 1 on page 2 of the above-identified Office action, US Patent No. 6,454,956 B1 corresponding to the document EP 0 901 157 A2 is enclosed herewith. Consideration of this document is therefore requested.

In item 3 on pages 2-3 of the above-mentioned Office action, claims 1-2, 4 and 5 have been rejected as being anticipated by Morgan (US Pat. No. 6,180,525) under 35 U.S.C. § 102(e). In item 5 on pages 3-4 of the above-mentioned Office action, claims 3 and 7 have been rejected as being unpatentable over Morgan in view of Paranjpe (US Pat. No. 5,434,107) under 35 U.S.C. § 103(a). In item 6 on page 4 of the above-mentioned Office action, claim 6 has been rejected as being unpatentable over Morgan in view of Ismail et al. (US Pat. No. 5,955,759) under 35 U.S.C. § 103(a).

The rejections have been noted and claim 1 has been amended in an effort to even more clearly define the invention of the instant application. More specifically, the feature of claim 2 has been added to claim 1.

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful.

Claim 1 calls for, inter alia:

forming the structures on the substrate from a material selected from the group consisting of noble metals, oxides of noble metals, and ferroelectric materials;

depositing a sacrifice layer on the structures and the substrate; and

removing the structures and the sacrifice layer in a polishing step.

The invention of the instant application specifically refers to a method for removing structures that can emerge in the production of ferroelectric storage capacitors. To produce ferroelectric capacitors, ferroelectric materials are usually used as the dielectric between the capacitor electrodes which are usually made of noble metals or oxides of noble metals.

Although ferroelectric materials and noble metals are quite different in general, both types of materials have in common

that they can only be structured by ion bombardment (for example argon sputtering) since there is, so far, no chemical etch process having a sufficient removal rate. Structuring a material layer by ion bombardment, however, unavoidably leads to so-called material redepositions on the sidewall of the mask layer. These redepositions (or fences) are shown in Fig. 11 of the instant application and they have to be removed in order to finalize the semiconductor product. However, as outlined in the specification of the present application (see page 4, last paragraph to page 5, second paragraph), it is not that easy to remove structures made of noble metals, oxides of noble metals and ferroelectric materials.

While the invention of the instant application provides a solution to this problem, none of the cited references is even concerned with the problem of how to remove structures (redepositions) of noble metals, oxides of noble metals and/or ferroelectric materials as these materials are rather specific in their behavior if exposed to chemical etching. Moreover, in those cited references, there are neither any hints relating to the problem that arises from using these materials nor to the solution found.

Morgan discloses a method of minimizing repetitive chemical-mechanical polishing scratch marks resulting from breaking away of surface peaks. Therefore, a portion of the volume between adjacent peaks is filled with a material and a chemical-mechanical polishing is initiated.

However, Morgan fails to disclose that the structures are made of noble metals, oxides of noble metals and/or ferroelectric materials. The material which is removed by Morgan is a simple silicon oxide with properties considerably different from the properties of the materials disclosed in the invention of the instant application.

Paranjpe discloses a method for planarization of the upper surface of a semiconductor wafer. The method of Paranjpe includes the steps of coating a wafer with a film of deformable material and applying uniform pressure. However, the method according to Paranjpe is considerably different from the method according to the invention of the instant application and, in particular, the method according to Paranjpe does not have the step of removing a material from the group consisting of noble metals, oxides of noble metals and ferroelectric materials.

In Ismail et al., a field effect transistor and method for making the same is described. However, Ismail et al. do not disclose any specific material removal process. In particular, Ismail et al. do not disclose any specific material removal process capable of removing a material from the group consisting of noble metals, oxides of noble metals and ferroelectric materials.

It is accordingly believed to be clear that none of the references, whether taken alone or in any combination, either show or suggest the features of claim 1. Claim 1 is, therefore, believed to be patentable over the art and claims 3-7 are ultimately dependent on claim 1, they are believed to be patentable as well. Claim 2 has been cancelled.

In item 7 on pages 5-6 of the above-mentioned Office action, claims 8-12 have been rejected as being unpatentable over Chien et al. (US Pat. No. 5,702,869) in view of Huff et al. (US Pat. No. 5,872,401) under 35 U.S.C. § 103(a).

As will be explained below, it is believed that the claims were patentable over the cited art in their original form and the claims have, therefore, not been amended to overcome the references.

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful.

Claim 8 recites a method for producing at least one structured layer, which comprises the steps of:

- a) providing a substrate;
- b) applying at least one layer to the substrate for structuring;
- c) applying a mask to the layer to be structured;
- d) etching the layer being structured by a dry etching method, so that redepositions of the layer emerge at sidewalls of the mask;
- e) removing the mask;
- f) applying a sacrificial layer; and
- g) performing a polishing step to remove the redepositions of the layer being structured, and to remove the sacrificial layer, so that a structured layer emerges.

Chien et al. teach a method for removing a partially fluorinated photoresist layer from a semiconductor substrate. However, Chien et al. do not disclose steps f) and g) of claim 8 of the instant application, as also stated by the Examiner (see the second paragraph from bottom on page 5 of the Office action). Yet these steps are most important for the claimed method of the instant application as they solve the problem of how to remove redepositions by applying a sacrificial layer and performing a polishing step so that no damages result to the device. In Chien et al., however, these redepositions are removed by employing first an oxygen containing plasma (see column 9, lines 35-36) and second a wet chemical etch method. No hints are given which would

link the method according to Chien et al. to the method according to claim 8 of the instant application.

Moreover, the position and structure of redepositions illustrated in Figs. 3, 4, 7 and 8 of Chien et al. are not such that the method of claim 8 of the instant application would be applicable since a polishing step which includes removing all of the redeposition would mean reducing the height of the layers 24a, 24b or 32a, 32b to the height of the conductor layers 22a, 22b and 30a, 30b, respectively, which is a contradiction to Fig.9.

Huff et al. disclose a method in which the SACVD layer 350 (see Fig. 3D) is subjected to an argon sputter etch 360 to eliminate large secondary voids (see column 5, lines 18-21). "Some of the material removed by the argon sputter etch is redeposited 370, 375. In narrower spaces, the redeposition is on the side walls, resulting in a pinching in 370. The pinching in 370 is below the metal level. This forces any voids that are subsequently formed to be below the metal level..." (see column 5, lines 25-32).

In Fig. 3G and column 5, lines 48-49 of Huff et al., it is taught that a sacrificial layer 390 is mounted to the etched SACVD layer 350 and afterwards planarized. "This planarization removes the excess oxide of the sacrificial

layer 390, and creates a very level surface for further processing. The planarization does not uncover any small voids 380 that may be present in the sacrificial layer 390, because these voids are below metal height in height." (see column 6, lines 11-16).

As can be clearly seen in Figs. 3E, 3F and 3G, redepositions 370 and 375 as well as the small voids 380 are below the metal height. Consequently, they are not supposed to be removed by the planarization process as this process has to be stopped above metal height. Thus, Huff et al. teach maintaining redepositions and small voids within the planarized complete ILD 400 in such a way that the device's operativeness is not affected. This is, however, a completely different approach as compared to claim 8 of the instant application, which teaches how to remove redepositions in such a way that the redepositions do not break off in the polishing process, and the material of the redepositions is not spread or smeared on the substrate by the polishing, which can lead to damage to the structures that have already be formed (see page 5, first paragraph of the specification of the instant application).

Thus, even if Huff et al. and Chien et al. were combined, Huff et al. would not be useful at all to a person skilled in the art to complete the missing steps of Chien et al.

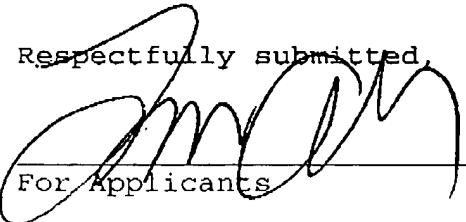
It is accordingly believed to be clear that none of the references, whether taken alone or in any combination, either show or suggest the features of claim 8. Claim 8 is, therefore, believed to be patentable over the art and claims 9-12 are dependent on claim 8, they are believed to be patentable as well.

In view of the foregoing, reconsideration and allowance of claims 1 and 3-12 are solicited.

In the event the Examiner should still find any of the claims to be unpatentable, counsel would appreciate a telephone call so that, if possible, patentable language can be worked out.

Please charge any fees which might be due with respect to Sections 1.16 and 1.17 to the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099.

Respectfully submitted,



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January 7, 2003

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Applic. No.: 09/845,405

Marked-Up Version of the Amended Claims:

Claim 1(amended). A method for removing structures, which comprises the steps of:

providing a substrate [having the structures to be removed];

forming the structures on the substrate from a material selected from the group consisting of noble metals, oxides of noble metals, and ferroelectric materials;

depositing a sacrifice layer on the structures and the substrate; and

removing the structures and the sacrifice layer in a polishing step.